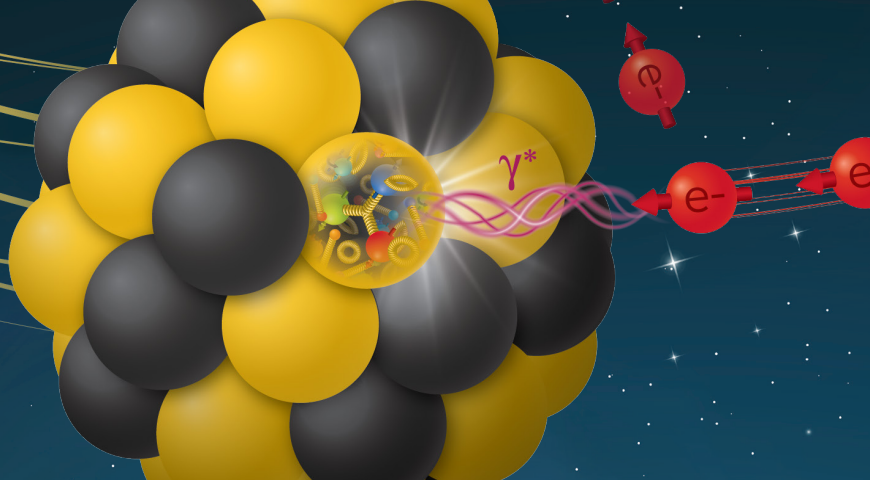
The Electron-Ion Collider (EIC)

Exploring the mysteries of the building blocks of matter



The Electron-Ion Collider (EIC), a powerful new facility to be built in the United States at the U.S. Department of Energy's Brookhaven National Laboratory in collaboration with Thomas Jefferson National Accelerator Facility, will explore the most fundamental building blocks of nearly all visible matter. Its focus is to reveal how these particles interact to build up the structure and properties of everything we see in the universe today, from stars to planets to people.

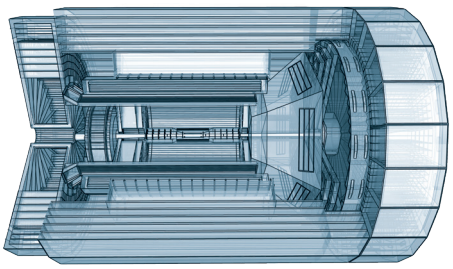
This exploration will provide insight into the workings of particles called gluons, which "glue" together quarks, the particles that make up protons and neutrons. For example, it will help explain how gluons contribute to the mass of visible matter and to "spin" —a property of fundamental particles that is used in medical imaging and quantum information science.

The EIC represents an opportunity for broad international communities of nuclear and accelerator physicists to collaborate on building this exciting new discovery machine. The project is attracting international partners who will contribute to accelerator and detector research and development (R&D), design, prototyping, and construction. This sharing of expertise will advance the evolution of state-of-the-art accelerator and detector technologies, with possible spin-off applications in a wide range of other fields.

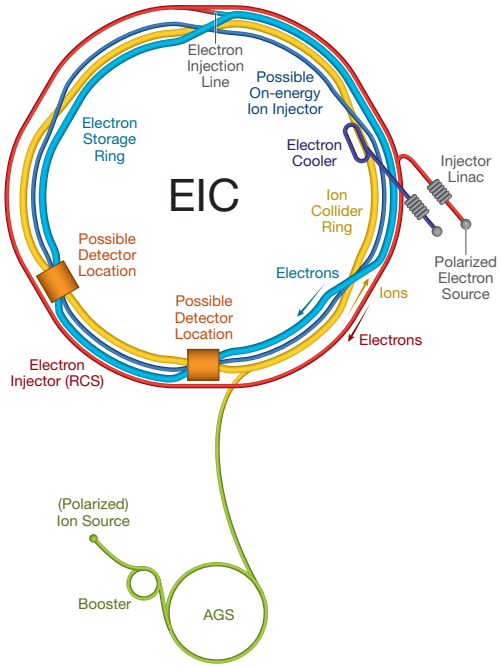
The world-leading science of the EIC and the technological advances needed to make it a reality have the potential to power the advanced technologies of tomorrow.

State-of-the-art detector technologies

Scientists will track particles produced by the colliding beams using a complex detector. This detector will act like a giant microscope to give insight into the properties of visible matter. Technologies required to enable discoveries at the EIC include:



- High-precision tracking systems for reconstructing the trajectories of charged particles
- High-resolution systems for measuring the energies of particles
- Components for precision particle identification
- Efficient data acquisition systems incorporating machine learning and artificial intelligence
- Advances in software and computing for analyzing data



An exciting new discovery machine

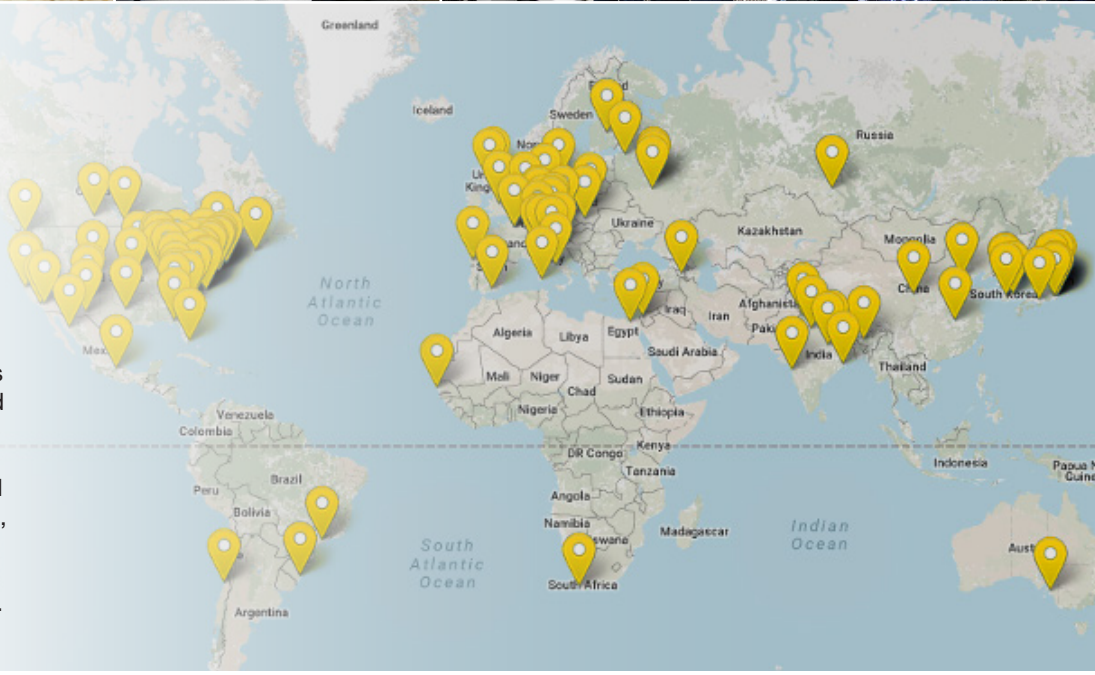
The EIC will consist of two intersecting, ring-shaped accelerators. One ring will store an intense beam of polarized electrons (where the particles' spins are oriented in a controlled way), while the other stores a counterrotating high-energy beam of polarized protons or ions (nuclei of atoms). Scientists will steer the electron and ion beams into collisions at a very high collision rate at points where the two rings intersect and collect data using detectors that surround these interaction regions.

The collider will feature specialized state-of-the-art technologies:

- Sources for producing ions and electrons
- Vacuum and cryogenics systems
- Superconducting radio-frequency cavities for accelerating ions/electrons and superconducting magnets for steering and focusing beams
- Instrumentation for measuring and correcting beam properties
- Spin rotator devices for maintaining particle spin direction
- Advanced systems for keeping particles in beams tightly packed to maximize collision rates

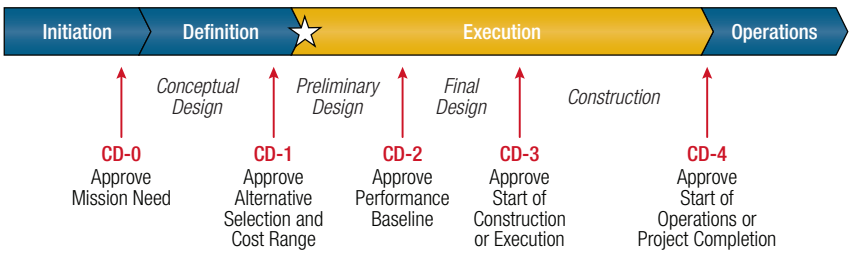
Vibrant international community

The growing EIC Users Group—currently 1,300+ physicists from more than 250 laboratories and universities around the world—have been extremely active in developing the science case for the EIC, plans for the accelerator and detector(s), and submitting collaboration proposals for detectors at the EIC. While the project scope includes funding for one detector, this international community has presented a compelling case for a second detector to take full advantage of the EIC's planned capabilities. We invite you to join the EIC community of experimental nuclear physicists, accelerators scientists, and theorists working to develop partnerships and a path for realizing the full scientific potential of this unique machine.



The time to join is now!

The EIC Project is jointly managed by the U.S. Department of Energy's Brookhaven National Laboratory and Thomas Jefferson National Accelerator Facility. It has passed the first two of five DOE "critical decision" (CD) milestones and is in the R&D and design phase (☆).The EIC represents a unique opportunity for the broad international scientific and accelerator communities to collaborate on realizing the EIC facility while advancing state-of-the-art accelerator and detector technologies at the only approved collider project worldwide. We invite you to be part of this groundbreaking research endeavor, and to contribute intellectually and through in-kind contributions. Construction is expected to start around 2024, with operations beginning in the early 2030s, followed by 20+ years of scientific impact and continuing opportunities for innovation and improvement.



Benefits beyond physics

Advances in accelerator and detector technologies like those required for the EIC often result in applications in other fields important for economic development and improving quality of life. Here are just a few examples:

- New medical isotopes and particle beam approaches for diagnosing and treating cancer
- Artificial intelligence and other computational tools for simulating climate change, tracking global pandemics, and protecting national security
- Accelerator advances for making and testing computer chips, studying proteins and therapeutic drugs, designing better batteries, and more
- Development of radiation-resistant materials for energy applications

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